



## Case report

## A case of "precocious" mummification

Gian Luca Marella MD, Forensic Pathologist, Emilio Perfetti MD, Forensic Pathologist\*, Stefano Manciocchi MD, Forensic Pathologist, Giovanni Arcudi MD, Professor of Legal Medicine

Section of Legal Medicine, University of Rome "Tor Vergata", Montpellier Street 1, Rome 00133, Italy

## ARTICLE INFO

## Article history:

Received 9 February 2012

Received in revised form

21 May 2012

Accepted 17 June 2012

Available online 3 July 2012

## Keywords:

Mummification

Post-mortem interval

Transformative phenomena

## ABSTRACT

Mummification is a peculiar transformative process consisting of the total drying of the body soft tissues. It is produced, in particular conditions, between 6 and 12 months after death. "Precocious" mummification has been reported in countries where recorded weather conditions are more extreme than in Italy, in a confined environment, or with particular micro-climate conditions. Here we present a case of mummification produced in a central region of Italy in four weeks. We also analyze conditions allowing for the rapidity of this phenomenon.

© 2012 Elsevier Ltd and Faculty of Forensic and Legal Medicine. All rights reserved.

## 1. Introduction

Mummification is a peculiar transformative process consisting of the total drying of the body soft tissues. It is produced in the presence of particular weather conditions and in association with some endogenous conditions that determine the degree of fluid leakage. Generally this process takes between 6 and 12 months to completely develop. In this work we analyze factors that produced a mummification context in a much shorter time period of four weeks.

## 2. Case report

## 2.1. The case

In September 2010 in Formia (Latina), human remains were identified along the railway line. These were spread along the platforms for about 350 m. Approximately four weeks before this finding, a male was reported missing in the same area. Genetic analysis of samples from the remains (tooth and fragment of right femur) taken during post-mortem examination demonstrated biological compatibility with the missing person.

## 2.2. Post-mortem examination

The examination was carried out after the remains were kept for 24 h in the refrigerator. Among the remains a pair of blue jean trousers, with various tears, and a brown sandal were found. The skin surface showed coloration varying from light brown to dark brown; skin consistency was hard and leathery (Fig. 1).

Various small lesions were ubiquitously present, consistent with postmortem animal activity. Amputations and lacerations were also identified. Fragments of the mandible and a portion of the left face continuous with neck and trunk skin were recognized; the latter represented the chest and upper part of the abdomen. Both upper limbs were affected by wide lesions, as well as simple and compound fractures. The right limb was amputated at the upper-third portion. The lower limbs showed similar features, and were also amputated.

Gross characteristics of the lesions and histological analysis of perilesional tissues were compatible with antemortem injuries (Fig. 2).

The thoracic cavity showed multiple fractures. A small portion of the right lung was identified; it showed a dark color and hard consistency. No other organs or viscera were identified.

## 3. Discussion

The discovery of human remains affected by trauma, ascribable to a major traumatic event, with subsequent transformative phenomena such as mummification, produces a complex

\* Corresponding author. Public Health Department, Section of Legal Medicine, Tor Vergata University, Montpellier Street 1, Rome 00133, Italy. Tel.: +39 0672596222; fax: +39 062025563.

E-mail address: [emilioperfetti@gmail.com](mailto:emilioperfetti@gmail.com) (E. Perfetti).



Fig. 1. General condition of the human remains during post-mortem examination.

investigation for the forensic pathologist. We were forced to proceed with the classical forensic investigations, including verifying the time of death, determining cause and manner of death, and identifying the remains.

In the case presented here, rather than the "normal" transformative processes that characterize putrefaction, we found features consistent with "mummification". Mummification is

a transformative process resulting from rapid fluid leakage, generally favored by a dry and windy external environment,<sup>1,2</sup> leading to obstruction of the normal progression of putrefactive and producing hydric tissue depletion<sup>3</sup> Considering endogenous factors affecting postmortem changes, mummification occurs more readily in bodies of lower weight, in older persons, and fetuses. It is more common in newborns than adults, due to lower body weight and thinner skin. Widespread hemorrhage and dehydration also predispose to natural mummification.<sup>4</sup>

The mummified cadaver has a brownish color and parchment-like skin adhering to the bones. In addition, there is an overall decrease in volume and weight, even when the internal organs appear thick and light. In the forensic literature,<sup>3,5,6</sup> mummification is reported as a process that generally takes between 6 and 12 months to occur. Cases of precocious mummification are reported<sup>7</sup> but they occurred in countries with more extreme weather conditions than Italy. Indeed, natural mummification occurs most commonly in hot, desert, or arid regions such as Egypt, Chile, or Peru<sup>8</sup> They also develop in a confined environment and in particular micro-climate conditions<sup>9</sup> Based on this data, we evaluated the recorded weather data<sup>10</sup> in the area where the remains were found. In the days before discovery of the remains, weather data were as described in Table 1.

As we can verify from the table, recorded temperatures (average temperature: 23.28 °C, maximum temperature recorded: 34.5 °C) were not exceedingly high while the humidity value (average relative humidity: 75.5%) was elevated. These data do not represent the typical conditions associated with the mummification process, least of all in a four week time period.

We attribute a fundamental role to the traumatic context. The decedent was hit by a train, causing wide lacerations diffusely throughout the body, as well as amputations of the limbs, which allowed for significant exsanguination. Widespread hemorrhages,

Table 1

Climate data for the 30 days prior to discovery of the corpse ( $T_{avg}$  = average daily temperature;  $T_{min}$  = minimum daily temperature;  $T_{max}$  = maximum daily temperature;  $H_{avg}$  = daily average relative humidity;  $H_{min}$  = daily minimum relative humidity;  $H_{max}$  = daily maximum relative humidity; rain = daily rainfall).

Date	$T_{avg}$ (°C)	$T_{min}$ (°C)	$T_{max}$ (°C)	$H_{avg}$ (%)	$H_{min}$ (%)	$H_{max}$ (%)	Rain (mm)
22-Aug-10	28.6	20.9	34.5	62	39	93	0
23-Aug-10	26.3	19.5	31.1	81	54	100	0
24-Aug-10	25.8	21	30.3	86	61	100	0
25-Aug-10	25.7	19.5	30.6	86	66	100	0
26-Aug-10	26	20.9	30.2	86	66	100	0
27-Aug-10	25.8	21.1	30.3	89	70	100	0
28-Aug-10	25.5	18.8	31.2	82	59	100	0
29-Aug-10	25.4	18.1	32	73	42	100	0
30-Aug-10	23.6	18.1	28.7	68	36	96	0.2
31-Aug-10	23.8	15.5	28.6	44	22	72	0
01-Sep-10	20.4	10.5	27.8	55	24	90	0
02-Sep-10	20.1	11.2	28.4	70	39	96	0
03-Sep-10	23.4	17.2	29	51	35	70	0
04-Sep-10	23.2	13.6	28.5	69	42	99	0
05-Sep-10	23.5	16.5	28.2	81	64	100	0
06-Sep-10	23.2	16.9	28.4	81	66	100	0
07-Sep-10	23.6	16.6	29.5	71	44	100	0
08-Sep-10	24.2	20.3	27.8	86	60	100	7.4
09-Sep-10	21.7	16.2	27.6	87	57	100	10
10-Sep-10	19.5	15	26	88	49	100	2.2
11-Sep-10	21.8	15.3	28.5	76	47	100	0
12-Sep-10	22	13.7	28	75	44	100	0
13-Sep-10	22.3	15.9	27.8	80	53	100	0.2
14-Sep-10	23.8	17.7	29.6	56	33	94	1.8
15-Sep-10	20.9	12.3	28.1	73	37	100	0
16-Sep-10	21	13.2	27.3	84	62	100	0
17-Sep-10	21.6	15.7	27.8	85	60	100	0
18-Sep-10	22.6	17.8	27	86	61	99	0
19-Sep-10	22.7	17	26.4	76	57	94	0.2
20-Sep-10	20.4	14.2	26.7	79	49	100	0



Fig. 2. Part of the left side of the face.

as stated above, represent a well-known factor favoring mummification, due to obstruction of the normal putrefactive processes.

Moreover, these lesions also increased the degree of post-mortem dehydration, by virtue of a larger contact surface between the body and the external environment.

Another factor we must consider is represented by postmortem animal and insect activity, especially that of micro-fauna. Indeed, macro-fauna activity generally leads to rough and incomplete skeletonization, often damaging bone segments in correspondence to the most exposed areas of the body.<sup>4</sup> However, in the present case we cannot underestimate the effects of micro-fauna, particularly larvae, represented in our climates predominantly by diptera.<sup>11</sup> A study using clothed and unclothed pig carcasses showed that the unclothed carcasses were heavily inundated by blow fly egg and, in direct sunlight, they also mummified rapidly. This resulted in the mass migration of larvae in search of other food sources.<sup>12,13</sup>

Evisceration also reduced the normal putrefactive processes and favored complete dehydration, above all in the thoracic and abdominal cavities.

#### 4. Conclusion

Only an approximation of time of death can be reached based on the presence of mummification.

In order to express an opinion in regards to the thanatocronology of a case, it is necessary to carry out an analysis considering both data in the scientific literature and specific factors of the individual case.

In summary, even in weather conditions that are not extreme, "precocious" mummification can occur over a period of four weeks, due in large part to environmental factors and bodily trauma.

#### Ethical approval

Not required.

#### Funding

None.

#### Conflicts of interest

None.

#### References

1. Evans WED. *The chemistry of death*. Springfield, IL: Charles C. Thomas; 1963.
2. Haglund WD, Sorg MH. *Forensic taphonomy: the postmortem fate of human remains*. CRC Press; 1997.
3. Umani Ronchi G, Bolino G, Traditi F. *La diagnosi dell'epoca della morte*. Milan: Giuffrè; 2002.
4. Umani Ronchi G, Anaclerio M, Arcudi G. *Tanatocronologia – attualità e prospettive*. Rome: Edizioni Colosseo; 1989.
5. Giusti G. *Trattato di medicina legale e scienze affini*. Padua: Cedam; 1998.
6. Gerin C, Antonioti F, Merli S. *Medicina legale e delle assicurazioni*. Rome: SEU; 1997.
7. Kashimura S, Umetsu K, Ikeda N, Suzuki T, Oumi M, Hanaya S. On a cadaver mummified within 25 days. *Jpn J Legal Med* 1984;**38**(3):376–80.
8. Saukko P, Knight B. *Knight's forensic pathology*. Arnold Press; 2004.
9. Marracino F, Umani Ronchi G. Su due casi di mummificazione naturale. *Rass Med For* 1968;**229**(Suppl. 1).
10. ARSIAL – Agency for regional development and innovation of agriculture (Regione Lazio). The agency is responsible for managing the integrated agro-meteorological service. <http://www.arsial.it>.
11. Introna Jr F, Candeloro D, Stasi AM. Determinazione dell'epoca della morte mediante analisi matematica della durata dei cicli di calliphora erythrocephala. *Riv It Med Leg* 1991;**13**:567.
12. Dillon LC. Insect succession on carrion in three biogeoclimatic zones in British Columbia. M.Sc. thesis: Department of Biological Sciences, Simon Fraser University, Burnaby. B.C.: 1997.
13. Dillon LC, Anderson GS. Technical report. *Forensic entomology – use of insects towards illegally killed wildlife*, vol. 1. Toronto: World Wildlife Fund; 1997.